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(71) Applicant: **W.R. Grace & Co.-Conn.
1114 Avenue of the Americas
New York New York 10036 (US)**

(72) Inventor: **Schirmer, Henry G
156 Edgecombe Road
Spartanburg, SC 29302 (US)
Inventor: Williams, Allen, Jr.
313 Sloping Meadow Drive
Spartanburg, SC 29303 (US)
Inventor: Nelson, Martin
121 Cherrywood Trail
Greer, SC 29650 (US)**

(74) Representative: **Bentham, Stephen et al
J.A. Kemp & Co. 14 South Square Gray's Inn
London, WC1R 5LX (GB)**

(54) **Blends of polypropylene and ethylene copolymer and films made from the blend.**

(57) A composition of matter comprises a blend of propylene homopolymer or copolymer, and ethylene copolymer. Ethylene vinyl acetate copolymer (EVA), very low density polyethylene (VLDPE), and ethylene alpha olefin copolymer are preferred ethylene copolymers. VLDPE with a high molecular weight (low melt index), and with a broad molecular weight distribution (high flow rate ratio) is preferred. A multilayer film comprises a first layer comprising a propylene homopolymer or copolymer, or blend, and at least one outer sealable layer.

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The present invention pertains to compositions for mailing packaging film, and more particularly to a thin polymeric film suitable for replacing polyvinyl chloride film specially in packaging applications.

Polyvinyl chloride (PVC) has long been used in many applications in the packaging art. One particularly wide-spread application for PVC is the use of such material as an overwrap material for trayed retail cuts of meat and other food products in a retail environment such as a supermarket.

PVC has several desirable properties for this use. For example, it has excellent burn-through resistance, optics and good elasticity and stretch properties at use temperatures.

Unfortunately, PVC also has several disadvantages, including the production of hydrogen chloride gas during heat sealing and the generally corrosive effects of such gases in the packaging room. Extractables from the PVC into the packaged food product have also become of concern.

It would be of great benefit to the packaging industry, and particular to applications requiring an instore film for overwrapping trayed food products, to provide a film with many of the advantages of PVC but without the disadvantages described above.

The inventors have discovered that a blend of propylene polymer or copolymer, and ethylene copolymer, is useful in improving the burn-through resistance of a film made from the blend.

The inventors have also discovered that a relatively thin polymeric film, including a layer of the blend combined with an outer heat sealable layer, can be made using the inventive blend.

Processes for producing oriented films, and oriented films themselves are disclosed in many patents including the following patents of interest.

U. S. Patent No. 3,456,044 (Pahlke) mentions thin films of thicknesses less than 1 mil such as 0.5 mils, and discloses a double bubble method for biaxially orienting thermoplastic films including the steps of producing a primary tubing which is inflated by introducing air into the interior thereof, and a cooling ring 22, as well as squeeze rolls 34 and 28, with rolls 34 having a greater speed than rolls 28. Between the two pairs of squeeze rolls is a reinflated secondary bubble. If annealing is desired, the tubing can be reinflated to form a bubble 70.

U. S. Patent No. 3,555,604 (Pahlke) is a patent based on a divisional application which was derived from the same priority application as the '044 patent described above, and discloses the same information described above for the '044 patent.

U. S. Patent No. 4,258,166 (Canterino et al) discloses a uniaxially oriented plastic film material with improved strength and clarity in the direction of orientation preferably comprising homopolymers and copolymers of ethylene.

U. S. Patent No. 4,355,076 (Gash) discloses monoaxially oriented polypropylene film laminated to a monoaxially oriented high density polyethylene film, the films produced by for example tubular blowing.

U. S. Patent No. 4,440,824 (Bonis) discloses a thermoformable coextruded multilayer structure useful for thermoforming into containers, the structure having polyolefin coextruded with a high impact polystyrene layer. A five layer structure is shown.

U. S. Patent No. 4,464,439 (Castelein) discloses a coextruded laminate having a sheet of polypropylene and a sheet of a mixture of high impact polystyrene, crystalline polypropylene, and styrene/dienic monomer block copolymer.

U. S. Patent No. 4,879,177 (Boice) discloses a monoaxially oriented shrink film having a core layer of butadiene styrene copolymer, outer layers of ethylene propylene copolymer, and intermediate bonding layers of ethylene copolymer.

It is an object of the present invention to provide a composition which can be included in a thermoplastic film useful as an overwrap material for trayed retail cuts of meat and other food products in a super market or other retail environment.

It is also an object of the present invention to provide a composition of matter which has good burn-through resistance when included in a film.

It is also an object of the present invention to provide a film having excellent optical properties, specifically excellent gloss and clarity.

The invention is a composition of matter comprising a blend of propylene homopolymer or copolymer, and ethylene copolymer.

In another aspect of the present invention, a multilayer film comprises a first layer comprising a blend of propylene homopolymer or copolymer, and ethylene copolymer, or polybutene, preferably ethylene copolymer; and an outer sealable layer.

In another aspect of the present invention, a method of making an oriented polymeric film comprises coextruding a first melt stream of a blend of propylene polymer or copolymer, and ethylene copolymer, and a second melt stream of a sealable polymeric material; extruding the melt streams through a tubular die; hot blowing the extruded film; heating the hot blown film to a temperature above its orientation temperature; directing the heated film through a first set of pinch rolls; reinflating the hot blown film by a blown bubble process wherein the bubble

is expanded in both its longitudinal and transverse directions; and collapsing the reinflated film through a second set of pinch rolls.

The term "polyolefin" is used herein in its stricter sense to mean a thermoplastic polymer derived from simple olefins. Among these are polyethylene, polypropylene and copolymers thereof with olefinic comonomers. For example, very low density polyethylene may be considered a linear ethylene copolymer with a comonomer comprising such materials as butene, hexene or octene. The term "polyolefin" is also used herein in a broader sense to include copolymers of ethylene with comonomers that are not themselves olefins, such as vinyl acetate (e.g. ethylene vinyl acetate copolymer or EVA).

The term "very low density polyethylene", or "VLDPE" is used herein to describe linear ethylene alpha-olefin copolymer (flexomer) having densities of generally between about 0.860 and 0.915 grams/cubic centimeter, and produced by a catalytic, low pressure process. "Ultra low density polyethylene" is also included in this term.

The term "ethylene vinyl acetate copolymer" (EVA) as used herein refers to a copolymer formed of ethylene and vinyl acetate monomers wherein the ethylene derived units are present in major amounts and the vinyl acetate derived units are present in minor amounts, preferably one (1) to thirty (30) percent by weight.

The term "styrene butadiene copolymer" (SBC) is used herein to denote thermoplastic copolymers, especially block copolymers containing a major portion (greater than 50%) of styrene and a minor proportion (less than 50%) of butadiene comonomer.

The terms "melt flow" and "melt index" are used herein to mean the amount, in grams, of a thermoplastic resin which is forced through an orifice of specified length and diameter in ten minutes under prescribed conditions in accordance with ASTM D 1238.

The term "flow rate ratio" (FRR) is used to mean a dimensionless number derived by dividing the flow rate (melt flow or melt index) at one Condition with the flow rate at another Condition (ASTM D 1238). FRR is indicative of molecular weight distribution. The higher the FRR, the broader the molecular weight distribution.

The term "ethylene copolymer" is used herein in its strict sense to mean copolymers of ethylene and a comonomer, and in its broad sense to include materials such as polybutene which can be substituted for this first group of materials.

The term "ethylene alpha olefin copolymer" is used herein to refer to copolymers of ethylene and higher alpha olefins such as butene, 1-methyl pentene, hexene, and octene.

The invention may be further understood by reference to the drawings herein, where:

FIG. 1 is a schematic cross section of a preferred embodiment of a multilayer film in accordance with the invention;

FIG. 2 is a schematic cross section of an alternative preferred embodiment of a multilayer film in accordance with the invention.

FIG. 3 is a schematic diagram indicating the apparatus and process by which the films of the present invention are made; and

A preferred composition is a blend of between about 20% and 80% propylene homopolymer or copolymer, and between about 80% and 20% very low density polyethylene. A more preferred composition is a blend of about 40% propylene homopolymer or copolymer, and about 60% very low density polyethylene. An even more preferred composition is a blend of about 60% propylene homopolymer or copolymer, and about 40% very low density polyethylene.

An especially preferred propylene resin is propylene ethylene copolymer such as that available from Fina under the designation Fina 8473 and Fina 8473x. These resins have an ethylene content of about 3% by weight.

Another especially preferred propylene resin is propylene homopolymer such as that available from Shell under the designation WRD5-981, with a melt flow rate of .6 to .8 grams/10 minutes (ASTM D 1238, Condition 230/2.16).

An especially preferred VLDPE is a high molecular weight resin such as DEFD 1015 from Union Carbide. This resin has a density of about .900 grams/cc, a melt flow rate of about 6 grams/ 10 minutes (ASTM D 1238, Condition 190/21.601), and a FFR ($l_{21}/l_{2.1}$) of about 50.

The preferred film structure is a multilayer composite having a core layer comprising a blend of propylene polymer or copolymer, and very low density polyethylene (VLDPE).

Preferred VLDPE resins are characterized by high molecular weight (i.e. relatively low melt index), broad molecular weight distribution (i.e. relatively high flow rate ratio), and relatively low crystallinity at processing temperatures.

For the VLDPE, a melt index (MI) of no more than about .15 grams/ 10 minutes (ASTM D 1238) (Condition 190/2.16) is preferred. A more preferred MI is .12 grams/ 10 minutes.

Preferred VLDPE resins can also be characterized by a melt index of no more than about .50 grams/ 10 minutes, more preferably no more than about .45 grams/ 10 minutes (ASTM D 1238) (Condition 190/5.0); no more than about 1.50 grams/ 10 minutes, and more preferably no more than about 1.35 grams/ 10 minutes

(ASTM D 1238) (Condition 190/10.); or no more than about 10 grams/ 10 minutes, and more preferably no more than about 6 grams/ 10 minutes (ASTM D 1238) (Condition 190/21.601).

For the VLDPE, a molecular weight distribution (flow rate ratio) of at least about 10 (I_{21}/I_5) (ASTM D 1238) is preferred. This value is derived by dividing the flow rate at Condition 190/21.6 by the flow rate at Condition 190/5.0. A more preferred FRR is 13.

Preferred VLDPE resins can also be characterized by a FFR of at least about 40, more preferably at least about 50 ($I_{21}/I_{2.1}$) (ASTM D 1238). This value is derived by dividing the flow rate at Condition 190/21.6 by the flow rate at Condition 190/2.16.

This preferred composition can be used in monolayer or multilayer film constructions.

Referring to Fig. 1, in one preferred film construction, outer layers 12 preferably comprise a polyolefin, more preferably an ethylene polymer or copolymer such as EVA. Styrenic polymers and copolymers, e.g. styrene butadiene copolymer such as that commercially available from Phillips under the designation KR-10 having a butadiene content of 25% by weight of the copolymer; or KK 36 (for fatty food contact) are also preferred.

In this embodiment of the invention, the outer layers 12 are bonded to the core layer 10 by means of intermediate layers 14 each comprising a polymeric adhesive and preferably a copolymer of ethylene, and more preferably an ethylene vinyl acetate copolymer (EVA). A more preferred EVA is one having a vinyl acetate content above about 18% by weight of the copolymer, and even more preferably about 28% by weight of the copolymer. Other polymeric materials, including chemically modified adhesives, can be used for layers 14 provided they process adequately in processes such as those disclosed herein. Blends of polymeric materials and polymeric adhesives can also be used for intermediate layers 14.

For outer layers 12, SBC resins having minor amounts of butadiene, ranging from about 1 to 50%, provide an optimum balance of stiffness and flexibility to the film.

For layers of the present invention which contain SBC, antifog/plasticizing agents such as Atmer 645 and/or Atmer 1010 are preferably included, more preferably in amounts of between about .5% and 10% by weight of the layer or layers. Even more preferably, between about 2% and 6% of such agents are included. The intermediate layers 14, and comparable layers in other films of the present invention, preferably also include such agents, more preferably in the .5% to 10% range.

The films of the present invention are preferably made by coextrusion techniques, combined with an apparatus and process depicted in Figure 3 and described in more detail below.

An alternative preferred composition is a blend of between about 20% and 80% propylene homopolymer or copolymer, and between about 80% and 20% ethylene vinyl acetate copolymer. A more preferred composition is a blend of about 70% propylene homopolymer or copolymer, and about 30% ethylene vinyl acetate copolymer. Another preferred composition is a blend of about 50% propylene homopolymer or copolymer, and about 50% ethylene vinyl acetate copolymer.

Preferred propylene polymers or copolymers for the alternative embodiment are the same as those described above.

Preferred ethylene vinyl acetate copolymer resins for the alternative embodiment are those of the type listed and described in Table 1.

This alternative composition can also be used in monolayer and multilayer film constructions. Figure 2 shows a preferred film construction made with the alternative blend composition.

The outer layers 12 and intermediate layers 14 each comprise the materials described for the film of Figure 1.

The interior layers 16 comprises a polypropylene polymer or copolymer/ethylene copolymer or polybutene blend such as the polypropylene/EVA blend just described.

The core layer 18 comprises very low density polyethylene, and preferably high molecular weight, broad molecular weight distribution materials such as those described herein.

Still another embodiment includes a five-layer film like that described for Figure 2, but without intermediate layers 14.

Figure 3 shows schematically a device for making the films of the present invention.

A single melt stream, or multiple melt streams including a first melt stream of a blend of propylene polymer or copolymer, and ethylene copolymer, are extruded or coextruded and exit as an extrudate through an annular die 12 in a conventional manner. The extruded film is hot blown to form a blown bubble 14.

Air cooling ring 16 positioned circumferentially around the blown bubble at the position shown cools the thermoplastic melt as it exits die 12.

An optional auxiliary chilling ring or rings 17 may also be positioned circumferentially around the blown bubble down stream from air cooling ring 16 to further chill the hot blown film.

The primary bubble 14 is melt oriented in both the machine and transverse directions. Various blow up ratios may be used, but preferably the primary bubble 14 is hot blown to a blow up ratio of between 1.5 and 8.0.

The primary bubble 14 is collapsed at pinch rolls 21.

To assist in this process, guide plates 18 are positioned at the extremities of the blown bubble 14.

The preferred process for carrying out the present invention permits the bubble to be immediately reinflated, after cooling, into the secondary bubble 20 and then expanded to impart orientation of the material in primarily the transverse direction, primarily the longitudinal direction, or in both the transverse and longitudinal directions. This "flexibility" in the preferred process permits films of the invention to be produced which are oriented primarily in one direction (monoaxially oriented films) or films which are oriented in both the longitudinal and transverse directions (biaxially oriented films).

The collapsed bubble is reinflated in a blown bubble process to stretch orient the blown and collapsed film. This is done in a conventional manner by trapping air or other hot gas within the secondary bubble 20 so that the material stretches at its orientation temperature transversely to impart further orientation of the material in the transverse direction. The secondary bubble 20 is collapsed at a second set of pinch rolls 22. A second set of guide plates 24 may be employed to assist in the collapsing process.

The second set of pinch rolls 22 is rotated at a speed faster than the first set of pinch rolls 21 if it is desired to impart stretch orientation in the machine or longitudinal direction to the thermoplastic material.

The recollapsed bubble 20 then passes from the second set of pinch rolls 22 to take up roll 26.

The take up roll 26 may be a mill log which can be immediately stored or shipped to a distributor or customer, or may be stored for further processing such as slitting into single wound film, machine or natural center fold film. Thus, as used herein the take up roll 26 represents any further processing, storage, or further modification of the double wound, collapsed film once it exits the second set of pinch rolls 22, and is used herein to denote any of these possible further processing steps.

It is preferred that a reservoir 28 of heated fluid be disposed at the lower end of primary bubble 14 in such a way that the collapsing material drawn through the primary set of pinch rolls 21 will pass in communication with the heated fluid. In this manner, the film is more uniformly heated and temperature control can be achieved. Thickened tape edges can be substantially avoided by such means.

Although the heated fluid of reservoir 28 is preferably hot water, other media may be used if temperatures above the 212°F limit of hot water are desired. For example propylene glycol (a food approved material), hot oil or hot emulsions may be used. One skilled in the art will understand that the exact nature of the heated fluid is not as critical as its effectiveness in helping to uniformly heat the collapsing bubble 14 as it is drawn through pinch rolls 21, and to uniformly heat the collapsing bubble 14 to a temperature above its orientation temperature.

The heated fluid may also be an "active" substance which not only reheats the surrounding film, but also actually coats the interior of the bubble as it passes over the reservoir. An example is a hot wax or other functional coating.

The heated fluid may be recirculated from the reservoir through a heating means 30 by means of conduits 32 or other suitable transfer means. Using the reservoir 28 of heated fluid, the types of materials which may be effectively used in the present process and device are increased.

Many different film constructions can be made using this process, including monolayer and multilayer films, especially those using the inventive blend compositions.

Biaxially oriented films of the present invention are useful in overwrap applications for overwrapping retail cuts of meat and non-food products.

Monoaxially oriented films are useful in shrink label applications for producing labels for vessels such as bottles and cans.

The term "monoaxially oriented" is used herein to mean films oriented primarily in the longitudinal direction. However, some incidental orientation can be present in the transverse direction, and this is sometimes desirable to help the film to grip a container or vessel after heat shrinking and to reduce the incidence of wrinkles in the final label. The term can also be used to refer to films oriented primarily in the transverse direction, with or without some incidental orientation in the longitudinal direction.

The invention may be further understood by reference to the examples which follow.

The examples below list preferred commercially available resins.

The resins used in these examples, and others useful in the invention, are identified in Table 1.

TABLE 1

	<u>RESIN</u>	<u>COMMERCIAL NAME</u>	<u>DESCRIPTION</u>	<u>COMPANY</u>
5	SBC ₁	KR-10	STYRENE BUTADIENE COPOLYMER	PHILLIPS
10	SBC ₂	KK-36	STYRENE BUTADIENE COPOLYMER WITH FATTY FOOD COMPLIANCE	Phillips
15	EVA ₁	ELVAX 3182	EVA (28% VA)	DU PONT
	EVA ₂	ELVAX 3165	EVA (18%VA)	DU PONT
	EVA ₃	3170	EVA (18% VA)	DU PONT
20	VLDPE ₁	XU 61509.32	VERY LOW DENSITY POLYETHYLENE DENSITY = .911 grams/cc	DOW
25	VLDPE ₂	DEFD 1161	VERY LOW DENSITY POLYETHYLENE	UNION CARBIDE
	VLDPE ₃	TAFMER 0680	VERY LOW DENSITY POLYETHYLENE DENSITY = .88 grams/cc	MITSUI
30	VLDPE ₄	1015	VERY LOW DENSITY POLYETHYLENE DENSITY = .900 grams/cc	UNION CARBIDE
35	PP ₁	8473	EPC	FINA
	PP ₂	WRD5-981	POLYPROPYLENE	SHELL
40	PL ₁	22-164	50% POLY-ISOBUTYLENE IN LLDPE	SANTECH

45 Example 1

VLDPE₄ alone, and pellet blends with PP₁ were extruded at 500°F barrel temperature on a 3/4 inch extruder (Brabender) and blown into 2 mil thick film from a 1 inch annular die set at 450°F with a blow-up ratio of 2.8:1.

50 The 2 mil films were then oriented into film using a hat tester on the following day. The results are shown below in Table 2.

Table 2

5	<u>Composition</u>	<u>Orientation Temperature</u>	<u>Results</u>
10	100% VLDPE ₄	210°F	clear film
15	80% VLDPE ₄ + 20% PP ₁	212°F	clear film
20	60% VLDPE ₄ + 40% PP ₁	225°F	clear film
25	40% VLDPE ₄ + 60% PP ₁	225°F	clear film
30	20% VLDPE ₄ + 80% PP ₁	225°F	couldn't orient due to improper mixing (gels)

Example 2

Double wound film (4 mils thick) of both 100% VLDPE₄ and the blend of 80% VLDPE₄ and 20% PP₁ were oriented on a hat tester (parallel orientation) at 210°F. A hat tester is a device for blow-orienting laboratory film samples. A film sample, having a size of about 4 inches by 4 inches, is clamped over an orifice situated in a horizontal table. An overhead radiant heater heats the film to a predetermined orientation temperature. Then, air is blown upwardly through the orifice to create an oriented hemispherical shape ("hat") in the film. In each case, the resulting hat was ply separated after orientation into two hats of oriented film.

Example 3

Multiple oriented hat samples for each of the compositions of Table 1 were made by the procedure described in Example 2. These hats were about .20 mils thick. A styrofoam disc with a diameter of 2.6 inches, and a 500 gram weight, were inserted into the cavity of each hat.

These hats were evaluated on a hot pad sealer to determine their burn-out threshold. The multiple hat samples for each composition, with the disc and weight therein, were each placed in turn on a hot pad preheated to different predetermined temperatures and left there for about 10 seconds. Each hat sample was evaluated for degree of burn-out. The aggregate results for each composition, are shown in Table 3.

Table 3

5	Composition (% PP ₁)	<u>Burn-out Threshold Temperatures</u>
	0	230 to 240°F
10	20	250 to 260°F
15	40	280 to 290°F
	60	290 to 300°F

20 Example 4

A film having the construction SBC₁/EVA₁/80% VLDPE₄ + 20% PP₁/EVA₁/SBC₁ is produced by the process described above for Figure 3. Tubular film is hot blown, collapse through a pair of pinch rolls and reinflated into a secondary bubble. The secondary bubble is stretched in the machine direction and in the transverse direction to produce a thin film.

The outer layers of SBC₁ each form about 15% of the final film gauge. The core layer of the blend of 80% VLDPE₁ and 20% PP₁ forms about 40% of the final film gauge by thickness. The intermediate adhesive layers of EVA₁ each comprise about 15% of the final film gauge.

30 Example 5

A film like that of Example 4 is made, by the same process, but having 20% VLDPE₄ + 80% PP₁ in the blend layer.

35 Example 6

A film having the construction SBC₁/EVA₂/VLDPE₄/30% EVA₂ + 70% PP₁/VLDPE₄/EVA₂/SBC₁ was produced by the process described above for Figure 3.

40 Example 7

A film having the construction SBC₁/EVA₂/VLDPE₄/50% EVA₂ + 50% PP₁/VLDPE₄/EVA₂/SBC₁ was produced by the process described above for Figure 3.

45 Example 8

A film having the construction SBC₁/EVA₂/VLDPE₄/70% EVA₂ + 30% PP₁/VLDPE₄/EVA₂/SBC₁ is produced by the process described above for Figure 3.

Additional films were produced by the process described above for Figure 3. These films are identified in Table 4 as Examples 9-18. In Example 12, the film contained 5% polypropylene by weight of the total film structure. In Example 13, polypropylene formed about 10% of the total film structure by weight. In Example 15, the core layer of the blend of EVA and polypropylene formed about 15% by weight of the total film structure. In Example 16, the core layer blend constituted about 20% of the total film structure. In Example 18, the same film structure was produced as in Example 17, but with a higher level of antifog agent. The films of Example 9-18 were oriented in the secondary bubble at a ratio of about 2.0:1 in each of the transverse and longitudinal directions.

Table 4

EXAMPLEFILM STRUCTUREBURNOUT
TEMP (°F)

9	SBC ₁ /EVA ₂ /80% VLDPE ₄ /EVA ₂ /SBC ₁ +20% PP ₂	280-300
10	SBC ₁ /EVA ₂ /90% VLDPE ₄ /EVA ₂ /SBC ₁ +10% PP ₂	280-300
11	SBC ₁ /EVA ₂ /70% VLDPE ₄ /EVA ₂ /SBC ₁ +30% PP ₂	280-300
12	SBC ₁ /EVA ₂ /VLDPE ₄ /PP ₂ /VLDPE ₄ /EVA ₂ /SBC ₁	290-310
13	SBC ₁ /EVA ₂ /VLDPE ₄ /PP ₂ /VLDPE ₄ /EVA ₂ /SBC ₁	290-310
14	SBC ₁ /EVA ₂ /VLDPE ₄ /50% EVA ₂ /VLDPE ₄ /EVA ₂ /SBC ₁ + 50% PP ₂	290-300
15	SBC ₁ /EVA ₂ /VLDPE ₄ /30% EVA ₂ /VLDPE ₄ /EVA ₂ /SBC ₁ + 70% PP ₂	315-330
16	EVA ₂ /VLDPE ₄ /50% EVA ₂ /VLDPE ₄ /EVA ₂ /SBC ₁ + 50% PP ₂	320-330
17	SBC ₁ /EVA ₂ /VLDPE ₄ /50% EVA ₂ /VLDPE ₄ /EVA ₂ /SBC ₁ + 50% PP ₂	320-330
18	SBC ₂ /EVA ₂ /VLDPE ₄ /50% EVA ₂ /VLDPE ₄ /EVA ₂ /SBC ₂ + 50% PP ₂	320-330

Additional films were made by standard blown film techniques, using about a 5:1 blow up ratio. These films are listed in Table 5 as Examples 19-27. The temperatures at which the films burned out in testing of the burn through resistance of the film are indicated in the right hand column of the table.

Another example of the present invention is a film including the construction:

SBC/ADH + PP/LDPE/ADH + PP/SBC

where ADH is a polymeric adhesive such as EVA₁, EVA₂, or EVA₃, or any suitable adhesives such as the carboxylic acid or acid anhydride-modified polymeric adhesives known in the art; and where PP is PP₁, PP₂, or other suitable propylene polymers or copolymers. ADH and PP may be blended in any of the proportions disclosed herein for PP blend layers.

Table 5

EXAMPLE	FILM STRUCTURE	BURNOUT TEMP (°F)
19	EVA ₂ /VLDPE ₄ /EVA ₂	260 +
20	EVA ₂ /VLDPE ₄ /90% VLDPE ₄ /VLDPE ₄ /EVA ₂ +10% PP ₂	280-290
21	EVA ₂ /VLDPE ₄ /75% VLDPE ₄ /VLDPE ₄ /EVA ₂ +25% PP ₂	310-320
22	EVA ₂ /VLDPE ₄ /50% VLDPE ₄ /VLDPE ₄ /EVA ₂ +50% PP ₂	320-330
23	EVA ₂ /VLDPE ₄ /25% VLDPE ₄ /VLDPE ₄ /EVA ₂ +75% PP ₂	340
24	EVA ₂ /VLDPE ₄ /PP ₁ /VLDPE ₄ /EVA ₂	270 +
25	SBC ₁ /EVA ₂ /80% VLDPE ₄ /EVA ₂ /SBC ₁ +10% PP ₂ +10% PP ₁	290-300
26	SBC ₁ /EVA ₂ /VLDPE ₄ /50% VLDPE ₄ /VLDPE ₄ /EVA ₂ /SBC ₁ +50% PP ₂	290-300
27	75% SBC ₁ /EVA ₂ /VLDPE ₄ /50% VLDPE ₄ /VLDPE ₄ /EVA ₂ /75% SBC ₁ +25% VLDPE ₃ / +50% PP ₂ / +25% VLDPE ₃	290-300

Films of the present invention can optionally be cross-linked. This can be done chemically or by the use of irradiation.

Irradiation may be accomplished by the use of high energy electrons, ultra violet radiation, X-rays, gamma rays, beta particles, etc. Preferably, electrons are employed up to about 20 megarads (MR) dosage level. The irradiation source can be any electron beam generator operating in a range of about 150 kilovolts to about 6 megavolts with a power output capable of supplying the desired dosage. The voltage can be adjusted to appropriate levels which may be for example 1,000,000 or 2,000,000 or 3,000,000 or 6,000,000 or higher or lower. Many apparatus for irradiating films are known to those of skill in the art. The irradiation is usually carried out at a dosage up to about 20 MR typically between about 1 MR and about 20 MR, with a preferred dosage range of about 2 MR to about 12 MR. Irradiation can be carried out conveniently at room temperature, although higher and lower temperatures, for example, 0°C to 60°C may be employed.

While the invention has been disclosed with reference to illustrative examples, those skilled in the art will understand that various modifications may be made to the invention as disclosed without departing from the sphere and scope of the claims which follow.

For example, in an alternative embodiment, a single layer of a blend of propylene polymer or copolymer, and ethylene copolymer (preferably VLDPE or EVA) can be adhered, either directly, by means of a polymeric adhesive layer, or by conventional lamination adhesives to a single layer of a sealable polymeric material by one of the methods disclosed herein, to produce a film with a preferred thickness of less than about 1 mil. Thus, both asymmetric and symmetric two, three, four, five, six, and seven layer structures can be made from the composition of the present invention. Additional layers can be added to these structures to meet specific end use requirements, such as toughness, barrier properties and the like.

Also, polybutene and ethylene butene copolymer can be used as an alternative ethylene copolymer in the inventive blend.

Claims

1. A composition comprising a blend of:
 - a) propylene homopolymer or copolymer; and
 - b) ethylene copolymer or polybutene.
2. A composition according to claim 1 wherein the ethylene copolymer or polybutene is
 - a) very low density polyethylene;
 - b) ethylene vinyl acetate copolymer;
 - c) polybutene; or
 - d) ethylene alpha olefin copolymer.
3. A composition according to claim 2 which comprises very low density polyethylene having a melt index before blending of no more than about 10 grams/10 minutes.
4. A composition according to claim 2 or 3 which comprises very low density polyethylene having a flow rate ratio ($I_{21}/I_{2.1}$) before blending of at least about 40.
5. A composition according to any one of the preceding claims comprising a blend of from 20% to 80% propylene homopolymer or copolymer, and from 80% to 20% ethylene copolymer.
6. A composition according to claim 5 comprising a blend of from 30% to 70% propylene homopolymer or copolymer, and from 70% to 30% ethylene copolymer.
7. A composition according to claim 6 comprising a blend of from 40% to 60% propylene homopolymer or copolymer, and 60% to 40% ethylene copolymer.
8. A composition according to claim 7 comprising a blend of about 50% propylene homopolymer or copolymer, and about 50% ethylene copolymer.
9. A multilayer film comprising:
 - a) a first layer comprising a composition as claimed in any one of the preceding claims and
 - b) an outer sealable layer.

10. A film according to claim 9 wherein the outer sealable layer forms less than about 8% of the total film thickness.
11. A film according to claim 9 or 10 wherein the outer sealable layer is adhered directly to the first layer.
12. A film according to claim 9, 10 or 11 wherein the outer sealable layer is adhered to the first layer by means of a polymeric adhesive disposed between the first and second layers.
13. A film according to claim 12 which comprises:
 - a) a core layer comprising a composition as claimed in any one of claims 1 to 8;
 - b) two outer layers each comprising a sealable polymeric material; and
 - c) two intermediate layers each bonding the core layer to a respective outer layer, and comprising a polymeric adhesive.
14. A film according to claim 12, which comprises:
 - a) a core layer comprising a composition as claimed in any one of claims 1 to 8;
 - b) two interior layers, each layer bonded to an opposite side of the core layer, and comprising very low density polyethylene;
 - c) two outer layers each comprising a sealable polymeric material; and
 - d) two adhesive layers each bonding an interior layer to a respective outer layer.
15. A multilayer film comprising:
 - a) a core layer comprising very low density polyethylene;
 - b) two outer layers each comprising a sealable polymeric material; and
 - c) two intermediate layers each bonding the core layer to a respective outer layer, and comprising a blend of a propylene polymer or copolymer, and a polymeric adhesive.
16. A film according to any one of claims 13 to 15 wherein the two outer layers each comprises from 0.1% to 10% by weight of each outer layer, of plasticiser.
17. A film according to any one of claims 13 to 16 wherein the two outer layers each have a thickness of less than 100 μ m (.04 mils).
18. A film according to any one of claims 13 to 17 wherein the two outer layers each comprise less than about 4% of the total film thickness.
19. A film according to any one of claims 13 to 18 wherein the adhesive or intermediate layers comprise an olefin polymer or olefin copolymer with adhesive properties.
20. A film according to any one of claims 13 to 19 wherein the adhesive or intermediate layers comprises ethylene vinyl acetate copolymer.
21. A film according to any one of claims 9 to 20 wherein the outer layer or layers comprise a sealable polymeric material which is an olefin polymer, olefin copolymer, styrenic polymer, or styrenic copolymer.
22. A multilayer film comprising:
 - a) a first layer comprising a propylene polymer or copolymer; and
 - b) at least one additional sealable layer comprising
 - i) very low density polyethylene,
 - ii) ethylene vinyl acetate copolymer; or
 - iii) styrenic polymer or copolymer.
23. A film according to any one of claims 9 to 22 wherein at least one layer of the film is crosslinked.
24. A method of making a polymeric film which comprises:
 - a) coextruding a first melt stream of a blend of propylene polymer or copolymer, and ethylene copolymer or polybutene, and a second melt stream of a sealable polymeric material;
 - b) extruding the melt streams through a tubular die;

- c) hot blowing the extruded film;
- d) heating the hot blown film to a temperature above its orientation temperature;
- e) directing the heated film through a first set of pinch rolls;
- f) reinflating the hot blown film by a blown bubble process; and
- g) collapsing the reinflated film through a second set of pinch rolls.

25. A method according to claim 24 which comprises in step a) and b)

- a) coextruding a first melt stream of a blend of propylene polymer or copolymer, and ethylene copolymer or polybutene, a second and third melt streams of a polymeric adhesive, and fourth and fifth melt streams of a sealable polymeric material; and
- b) extruding the melt streams through an annular die such that the first melt stream forms the central layer of the coextrudate, and the fourth and fifth melt streams form the outermost surfaces of the coextrudate.

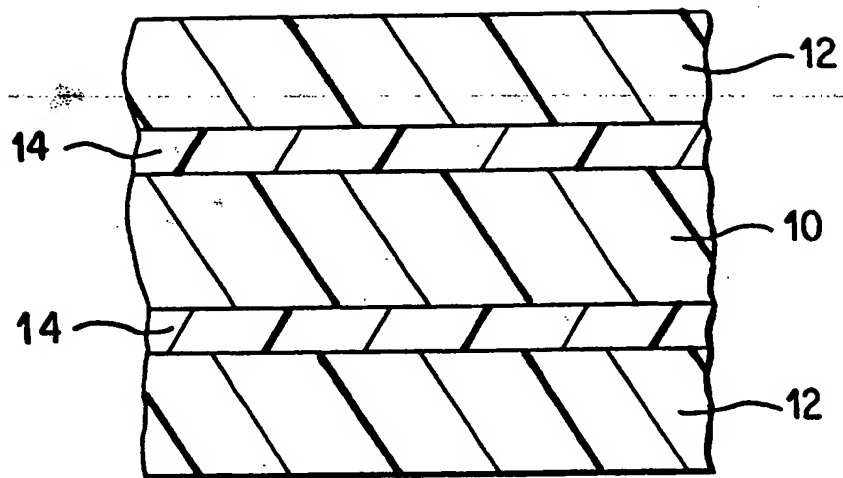


FIG. 1

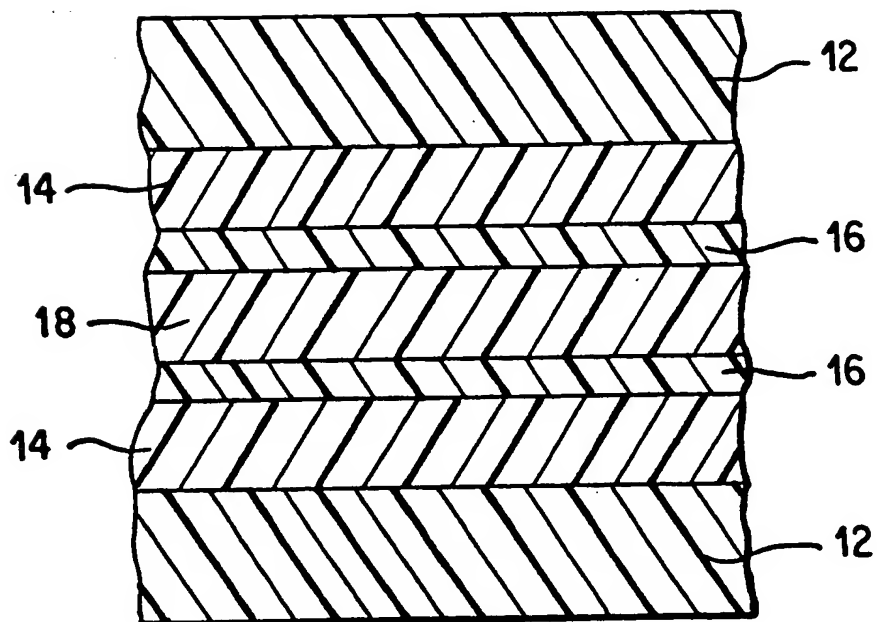


FIG. 2

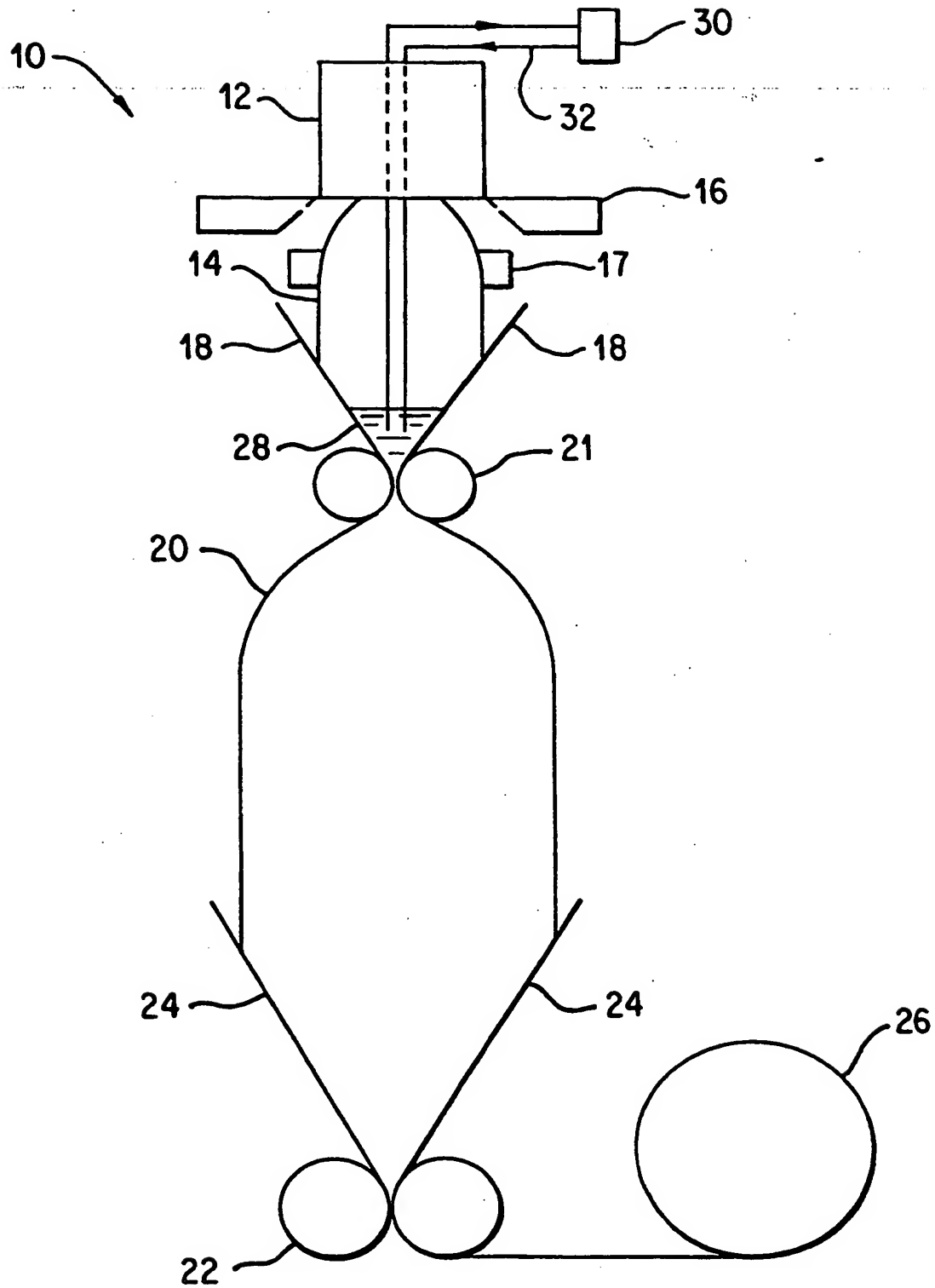


FIG. 3